A SHEET PROCESSING SYSTEM AND METHOD FOR CONTROLLING SUCH SYSTEM

[0001] This non provisional application claims priority under 35 U.S.C. § 119(a) on Patent Application No. 03076006.0 filed in Europe on April 3, 2003.

FIELD OF THE INVENTION

[0002] The present invention relates to a system for processing printed sheets. The system may be a stand-alone system such as a finisher or may be part of an image reproduction system such as a printing or copying system. The present invention further relates to a method for controlling such a sheet processing system.

BACKGROUND OF THE INVENTION

[0003] In order to reproduce images, it is generally known to feed a medium in sheet or web form through an image forming part of an image reproduction system such as a printing and/or copying system to form images of a marking substance thereon. In the case where the print medium is in web form, the print medium may be subsequently cut into sheets. The printed sheets may be conveyed to a sheet processing system. The sheet processing system may be an integral part of the image reproduction system or may be a stand-alone system operating in-line with the image reproduction system. The printed sheets are typically conveyed separately and in consecutive order to an input of such a sheet processing system at the processing speed of the image reproduction

system. Subsequently, the printed sheets are conveyed consecutively at the processing speed of the sheet processing system along a predetermined path through the sheet processing system where they may be subjected to all kinds of finishing treatments.

[0004] Alternatively, the sheet processing system may be a stand-alone system operating off-line. In the latter case a stack of printed sheets is usually offered to the sheet processing system for further processing. In operation, such a sheet processing system retrieves sheets from the stack and conveys them consecutively at the processing speed of the system along a predetermined path through the sheet processing system where they may be subjected to all kinds of finishing treatments. Examples of finishing treatments include but are not limited to cutting, punching, inverting, sorting, trimming, rotating, stapling and folding to obtain finished sheets, sets of finished sheets or booklets, which may be subsequently deposited at a sheet deposition station on a selected tray.

[0005] Regardless of the configuration, when sheets are conveyed through the sheet processing system at the processing speed, a problem may arise with some of the finishing treatments as they may require more time than the interval period between two consecutive sheets. Examples of such time-consuming finishing treatments include, e.g., stapling and folding. A potential solution to such a problem would be to decrease the processing speed so as to enable the execution of such time-consuming finishing treatments within the interval period between two consecutive sheets. Such a solution has several disadvantages. Firstly, degrading the processing speed degrades the sheet processing

capability and the efficiency of the sheet processing system. Secondly, when the sheet processing system is an integral part of or is placed in-line with an image reproduction system, lowering the processing speed of the sheet processing system may also adversely affect the processing capability of the entire image reproduction system as the processing speed of the sheet processing system should be at least as high as the processing speed of the image reproduction system. Therefore, gaining time to execute a finishing treatment by degrading the processing speed of the sheet processing system is not a desirable solution.

RELATED ART

[0006] In US 6,219,503 a sheet processing system is disclosed which, in the case a time-consuming finishing treatment has to be effectuated on a sheet or a set of sheets, the system temporarily stops conveyance of a succeeding sheet and places it in a waiting state on a buffer roller at least until the time-consuming finishing treatment is completed. Thereafter, the sheet which has been temporarily put in a waiting state is further conveyed in a super-imposed relationship with the consecutive non-stopped sheet. In order to put a sheet in and out of the waiting state, the buffer roller each time needs to be stopped and afterwards accelerated within the interval period between two succeeding sheets. The repetitive stopping and acceleration of the buffer roller is a disturbing noise source and negatively affects the system's reliability. Moreover, due to the fact that the stopping and acceleration of the buffer roller needs to be executed within the limited interval period between two

succeeding sheets, the disclosed approach is not scaleable to high processing speeds as the interval period between two succeeding sheets becomes too small to enable timely and reliable stopping and acceleration of the buffer roller

OBJECTS OF THE INVENTION

[0007] It is an object of the present invention to provide a sheet processing system capable of executing a finishing treatment on a sheet or a set of sheets without degrading the processing speed of the sheet processing system.

[0008] It is a further object of the present invention to provide a sheet processing system capable of temporarily buffering sheets when executing a finishing treatment on a preceding sheet or a set of preceding sheets while limiting noise generation and without negatively affecting the reliability of the system.

SUMMARY OF THE INVENTION

[0009] In a first aspect of the present invention, a sheet processing system is disclosed for feeding sheets successively along a supply path to a sheet deposition station where the sheets are collected, the sheet processing system containing means for temporarily interrupting the supply of successive sheets to the sheet deposition station to enable processing of the sheets collected at the sheet deposition station, the means for temporarily interrupting the supply of successive sheets comprising:

a sheet buffering member having an endless outer surface,

supply means for supplying sheets successively to the endless surface of the sheet buffering member, and

means for conveying sheets assembled on the endless surface of the sheet buffering member to the sheet deposition station.

[0010] The sheet buffering member, when sheets are supplied thereto, is continuously cycled with a cycling period for assembling successively supplied sheets on its endless outer surface in a superimposed relationship, the superimposed relationship being such that each subsequent sheet of the conveyed sheets at least partially overlaps with the preceding sheet assembled on the endless surface of the sheet buffering member while completely avoiding covering the endless outer surface of the sheet buffering member. A time-consuming finishing treatment is a finishing treatment which cannot be performed within the interval period between two succeeding sheets. When a time-consuming finishing treatment is to be performed on a sheet or a set of sheets, in order to gain the time required to enable the execution of the time-consuming finishing treatment, the supply of successive sheets to the sheet deposition station needs to be temporarily interrupted. According to the present invention, a sheet buffering member, which is continuously cycled when sheets are supplied thereto, is provided to enable the temporary buffering of the sheets. Particularly, sheets supplied to the endless surface of the continuously cycling buffering member are assembled thereon in superimposed relationship. To enable the further conveyance of the superimposed sheets to the sheet

deposition station, the superimposition of the sheets is such that the superimposed sheets completely covering the endless outer surface of the buffering member is avoided. Temporarily buffering the sheets by assembling them on a continuously cycling sheet buffering member obviates the need to degrade the processing speed of the sheet processing system. The sheet deposition station may be an intermediate sheet deposition station. The cycling period of the sheet buffering member may be greater than the interval between the arrival of the leading edge of a first sheet and the arrival of the leading edge of a second successive sheet at the endless outer surface of the sheet buffering member.

[0011] In an embodiment of the present invention, the cycling period of the sheet buffering member is smaller than or equal to the interval between the arrival of the leading edge of a first sheet and the arrival of the leading edge of a second successive sheet at the endless outer surface of the sheet buffering member. By doing so, it is obviated that, when buffering sheets on the continuously cycling buffering member, successive sheets are assembled offset from each other in such a way that the trailing edge of the superimposed sheets is the trailing edge of the first assembled sheet on the buffering member. In the latter case, the alignment of the set of superimposed sheets would be cumbersome.

[0012] In another embodiment of the present invention, the cycling period of the sheet buffering member is smaller than the interval between the arrival of the leading edge of a first sheet and the arrival of

the leading edge of a second successive sheet at the endless outer surface of the sheet buffering member. By doing so, a slight offset is created between the successive sheets assembled in superimposed relationship on the endless surface of the sheet buffering member. As a consequence, each sheet has a portion at its trailing edge in contact with the endless surface. An advantage hereof is that a more reliable transport of the sheets can be realised compared to the transport of superimposed sheets being in perfect alignment, i.e. zero offset between the respective sheets. The reliability of the transport can even be further improved when at least a portion of the endless outer surface of the sheet buffering member is composed of an adhesive material, said portion covering the entire circumference of the sheet buffering member. For instance, in the case where the buffering member is a buffering roller, such portion is typically an annular portion.

[0013] In another embodiment of the present invention, the sheet processing system according to the present invention further comprises at least a first pressure member and a second pressure member, wherein each pressure member can be resiliently urged against the endless outer surface of the buffering member while any sheet assembled on the cycling buffering member is guided there-between. Preferably, the first and second pressure member and any further pressure member is positioned such that in operation at any time at least one of the first, the second, or any further pressure member contacts the superimposed sheets assembled on the outer surface. Doing so is advantageous in providing a reliable paper transport on the

buffering member. More preferably, the first, the second, and any additional pressure members are rotatable.

[0014] In a preferred embodiment of the present invention, a sheet processing system is disclosed comprising:

a sheet buffering member operable in one of at least a first mode and a second mode, the sheet buffering member having an endless outer surface;

supply means for supplying sheets successively to the endless outer surface of the sheet buffering member; and

control means for controlling the sheet buffering member to operate in the first mode, wherein sheets successively supplied to the endless outer surface of the sheet buffering member are successively transported on and released from the endless outer surface of the sheet buffering member, or in the second mode. Particularly, the sheet processing system is adapted such that, when the sheet buffering member is controlled to operate in the second mode, the sheet buffering member is continuously cycled with a cycling period for assembling successively supplied sheets on its endless outer surface in a superimposed relationship, the superimposed relationship being such that each second or any following sheet of the conveyed sheets at least partially overlaps with the preceding sheet assembled on the endless surface of the sheet buffering member while avoiding completely covering the endless outer surface of the sheet buffering member.

[0015] Further, according to the present invention, the control means may comprise a switch for acting on the buffering member such

that the buffering member is controlled to operate in the first or in the second mode.

[0016] When a time-consuming finishing treatment is to be performed on a sheet or a set of sheets, in order to gain the time required to enable the execution of the time-consuming finishing treatment, sheets arriving at the endless surface of the buffering member during the execution of the finishing treatment, need to be temporarily buffered. According to the present invention, in such a case the control means control the sheet processing system to operate in the second mode. In this mode sheets arriving at the endless surface of the continuously cycling buffering member are assembled thereon in superimposed relationship till the control means control the sheet processing system to operate again in a mode different from the second mode, e.g. the first mode. This is done such that the sheet(s) which are temporarily assembled on the continuously cycling buffering member are further conveyed in superimposed relationship towards a sheet deposition station. The sheet deposition station may be an intermediate sheet deposition station. This means that the assembled sheets include both the sheets which haven been completely cycled and the first succeeding sheet. For example, if one sheet is buffered, in other words is subjected to a complete cycle on the buffering member, two sheets are assembled on the buffering member. To enable the further conveyance of the superimposed sheets, the superimposition of the sheets is such that the superimposed sheets completely covering the endless outer surface of the buffering member is avoided.

[0017] In another aspect of the present invention, a method for controlling a sheet processing system is disclosed in which

a sheet buffering member is provided to operate in one of at least a first mode and a second mode, the sheet buffering member having an endless outer surface; and

supply means is provided for supplying sheets successively to the endless outer surface of the sheet buffering member, wherein the sheet buffering member is controlled to operate in the first mode, wherein sheets successively supplied to the endless outer surface of the sheet buffering member are successively transported on and released from the endless outer surface of the sheet buffering member, or in the second mode. When the sheet buffering member is controlled to operate in the second mode, the sheet buffering member is continuously cycled with a cycling period for assembling successively supplied sheets on its endless outer surface in a superimposed relationship, the superimposed relationship being such that each second or any following sheet of the conveyed sheets at least partially overlaps with the preceding sheet assembled on the endless surface of the sheet buffering member while completely avoiding covering the endless outer surface of the sheet buffering member.

[0018] Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes

and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings, which are given by way of illustration only, and thus are not limitative of the present invention, and wherein:

[0020] Fig.1 depicts a schematic representation of a sheet processing system according to an embodiment of the present invention; Fig.2 depicts enhanced views of a portion of the sheet processing system as depicted in Fig.1. In particular, several operational stages (a) to (e) are disclosed clarifying the operation of the sheet processing system when operating in the buffering mode;

[0021] Fig.3 depicts an enhanced perspective view of the buffering portion of the sheet processing system as depicted in Fig.1. In particular, several operational stages are disclosed clarifying the operation of the sheet processing system when operating in the buffering mode;

[0022] Fig.4 depicts a schematic representation of a sheet buffering member and a switch acting thereon, according to an embodiment of the present invention. In Fig. 4(a) the switch is controlled such that any sheet assembled on the buffering member is released therefrom. In Fig. 4(b) the switch is controlled such that any sheet assembled on the buffering member is cycled; and

[0023] Fig.5 depicts a schematic representation of a sheet processing system according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0024] In Fig.1 a sheet processing system (1) according to an embodiment of the present invention is schematically depicted. The sheet processing system may be a stand-alone system or may be an integral part of an image reproduction system such as e.g. a printing or copying system. Sheet or sets of sheets (2) can be inputted and are fed consecutively along a predetermined path to a sheet deposition station (3), where they are deposited. In fig.1 two predetermined paths are disclosed. When the sheets or set of sheets are controlled to follow predetermined path A, then they are fed without being subjected to a further finishing treatment at the processing speed of the sheet processing system to a sheet deposition station where they are flipped and deposited on a selected tray (8). When the sheets or set of sheets are controlled to follow predetermined path B, then control means are provided enabling the sheet processing system to operate in the normal mode. In this mode sheets are successively guided and fed using guiding and drive means including a continuously cycling buffering member (10) to an intermediate sheet deposition station (4) where a predetermined number of sheets is assembled in correspondence with the job definition. Subsequently the set of assembled sheets is aligned and stapled by a stapler (5). As the stapling action requires more time than the interval period between two sheets successively fed along predetermined path B

towards the stapling position, such action is considered to be a time-consuming action and therefore the sheet(s) immediately following the set of sheets to be stapled are buffered in order not to degrade the processing speed of the sheet processing system. As will be described in more detail below, in order to enable the temporary buffering of sheets, the sheet processing system is controlled to operate in a buffering mode wherein those sheets are temporarily buffered before forwarding them to the intermediate sheet deposition station. When the stapling action is completed the buffered sheet(s) together with the first consecutive sheet are fed to the intermediate sheet deposition station. Simultaneously the stapled set of sheets (6) is further fed along a predetermined path B to a sheet deposition station, where the set is flipped and deposited on a selected tray (9). The trays (8)(9) are part of a flexible sheet deposition unit (7) for depositing sheets on a selected one of multiple trays facing a selected one of multiple outputs of the sheet processing system. Preferably, drive means and guide members (not shown) should be provided such that each tray can be moved up and down so as to face an output of the sheet processing system such that the distance between adjacent trays can be adjusted. For instance, in the case of two sheet deposition stations as in Fig.1, sheets produced in a "booklet mode" may be directed to a first sheet deposition station where stapled sets of sheets are deposited on a selected tray (9) while sheets produced in a "sheet mode" are directed to the other sheet deposition station where they are deposited on a selected tray (8). Alternatively, the respective sheet deposition stations may also be selected, instead of being dependent on

the finishing steps applied, e.g. single sheets versus booklets, dependent on format, e.g. A3 vs. A4, or on the sorting mode, e.g. sorting versus non-sorting, or the like.

[0025] Before arriving at the sheet deposition unit, the print medium may be subjected to all kind of finishing treatments including but not limited to cutting, punching, inverting, sorting, stapling and folding such as to obtain finished sheets, sets of finished sheets or booklets. The print medium is typically composed of paper, film, cardboard, label stock, plastic or textile. The sheet deposition unit may form an integral part of the sheet processing system or may be a separate unit which can be put in-line with the sheet processing system.

[0026] The sheet processing system disclosed in Fig.1 can be controlled to operate in a buffering mode. In the buffering mode, sheets are temporarily buffered on a continuously cycling buffering member (10) before forwarding them to the intermediate sheet deposition station (4) in order to provide the time required to execute proper alignment and stapling of a previous set of sheets assembled on the intermediate tray (4) in correspondence with the job definition. This buffering is executed without degrading the processing speed of the sheet processing system. In this mode sheets arriving at the endless surface of the continuously cycling buffering member are assembled thereon in superimposed relationship till the control means control the sheet processing system to operate again in a mode different from buffering mode, e.g. the normal mode. Suppose for instance that two consecutive sheets need to be buffered. Referring to Fig.1, Fig.2 and Fig. 3, this may be done as

follows. As depicted in Fig.2(a), a first sheet (21) is fed along predetermined path B to the endless surface (14) of the continuously cycling buffering member. As the sheet processing system is controlled by control means to operate in the buffering mode, the sheet (21) is guided along path B' instead of further following path B as can be seen in Fig.2(b). To enable this, the control means comprise a switch (12) acting on the buffering member. The switch is discussed in more detail with reference to Fig.4. The switch is in a position such that the first sheet assembled on the buffering member is continuously cycled with a cycling period. While the first sheet (21) is cycled, a second consecutive sheet (22) is fed along predetermined path B towards the endless outer surface of the buffering member. Two rotatable pressure members (11) are provided, each of them being resiliently urged against the endless outer surface (14) of the buffering member such that any sheet assembled on the cycling buffering member is guided there-between. The rotatable pressure members are positioned such that in operation at any time at least one of the rotatable pressure members contacts the sheets assembled on the buffering member.

[0027] The interval time between the arrival of the leading edge of the first sheet (21) at the endless outer surface and the arrival of leading edge of the second consecutive sheet (22) at the same position is known as the processing speed of the sheet processing system is known as well as the distance between the two consecutive sheets. Use can be made of known position detection means to accurately determine the arrival of the sheets at the endless outer surface of the buffering member to

determine the interval time between two consecutive sheets. The data registered by the detection means may be used by the control means to slightly adapt the cycling period of the buffering member and/or the processing speed of the sheet processing system to compensate for possible synchronisation errors, i.e., errors resulting in slight variations in the interval time between respective sheets guided along predetermined path B and/or B'. Additional position detection means may be positioned along predetermined path B and B' to allow for a more accurate monitoring and compensation when required. The cycling period of the buffering member is chosen dependent on the interval time between the two consecutive sheets. As can be seen in Fig.2(c), the buffering member is driven such that when the leading edge of the consecutive sheet (22) arrives at the endless surface (14) of the sheet buffering member (10), simultaneously the leading edge of the buffered sheet (21) arrives at the same position. The respective sheets are further subjected in superimposed relationship to the cycling motion of the buffering member. Alternatively, as depicted in Fig. 3, the cycling period is chosen such that the leading edge of the second sheet (22) arrives at the endless surface of the buffering after the arrival of the leading edge of the first sheet. In the latter case, the respective sheets only partially overlap each other. Care should be taken that the overlap is sufficiently large to ensure that the complete covering of the endless outer surface of the sheet buffering member is avoided. The configuration as depicted in Figs.2 and 3 is such that the interval time between two consecutive sheets is smaller than or equal to the cycling period, assuming that the

preceding sheet is cycled only once. Alternatively, the cycling period is chosen such that the interval time is about an integer multiple of the cycling period.

[0028] Two sheets are now buffered on the endless surface of the buffering member. By so doing, enough time is provided for executing the alignment and stapling of a preceding set of sheets. Thus, the two buffered sheets may now be guided along predetermined path B towards the intermediate deposition location (4). To enable this, again the buffering member is cycled such that the leading edge of the consecutive sheet (23) arrives simultaneously (Fig 2(d)) or shortly after (Fig.3) the leading edge of the preceding sheet (2). The three sheets now assembled in superimposed relationship on the endless surface of the sheet buffering member are transported further in superimposed relationship. Again care is taken to avoid the complete coverage of the endless surface. As can be seen in Fig.2(e), by switching the switch (12) the control means now control the sheet processing system to operate again in the normal mode and the cycling buffering member conveys the sheets (21, 22, 23) assembled on its surface in superimposed relationship further along predetermined path B towards the intermediate sheet deposition station (4).

[0029] In Fig.4 an example of a sheet buffering member (10) having an endless outer surface (14) and a switch (12) acting thereon is schematically depicted. The rotatable buffering member comprises 5 discs, positioned equidistant one with respect to another. A silicone rubber belt is mounted on the second and the fourth disc. By so doing

the endless surface of the buffering member comprises two adhesive endless surface portions which ensure a reliable transport of the sheets on the buffering member.

[0030] In Fig.5 a sheet processing system (1) according to an embodiment of the present invention is schematically depicted. The sheet processing system may be a stand-alone system or may be an integral part of an image reproduction system such as e.g. a printing or copying system. Sheets (2) are inputted consecutively at an input and are fed along a predetermined supply path C to an intermediate sheet deposition station (4) where a predetermined number of sheets is collected in correspondence with the job definition. Subsequently the set of assembled sheets is aligned and stapled by a stapler (5). The stapled set of sheets (6) is fed further to a sheet deposition station, where the set is flipped and deposited on a selected tray (9). The tray (9) may be part of a flexible sheet deposition unit (7) for depositing sheets on a selected one of multiple trays facing the output of the sheet processing system. Before arriving at the sheet deposition unit, the print medium may be subjected to all kind of finishing treatments including but not limited to cutting, punching, inverting, sorting, stapling and folding so as to obtain finished sheets, sets of finished sheets or booklets. The sheet deposition unit may form an integral part of the sheet processing system or may be a separate unit which can be put in-line with the sheet processing system. When the stapling action requires more time than the interval period between two sheets successively fed along supply path C towards the stapling position, such action is considered to be a time-consuming

action. In such case the sheet processing system is controlled such that the sheet(s) immediately following the set of sheets to be stapled are temporarily buffered in order not to degrade the processing speed of the sheet processing system. To accomplish this, at least the sheets which need to be buffered are directed along supply path D. These sheets are temporarily buffered on a continuously cycling buffering member (10) before being forwarded to the intermediate sheet deposition station (4). This buffering is executed without degrading the processing speed of the sheet processing system. Sheets arriving at the endless surface of the continuously cycling buffering member are assembled thereon in superimposed relationship till the sheet processing system is controlled to release the assembled sheets from the surface of the sheet buffering member. The released sheets are directed to the intermediate sheet deposition station (4) for further handling. It is clear to a person skilled in the art that sheets following the buffered sheets could already have been controlled to follow supply path C by adequately programming the control means such that they arrive timely at the intermediate sheet deposition station. When the stapling action on a preceding set of sheets is completed, the buffered sheet(s) are fed further along path D to the intermediate sheet deposition station, while the sheets following the buffered sheets are conveyed further along supply path C to the intermediate sheet deposition station. Alternatively, one could also opt to control the sheet buffering member such that it can be operated also in a non-buffering mode as disclosed in any of the previous embodiments. In the latter case, sheets can be controlled to follow supply path D

without being buffered on the sheet buffering member. When the stapling action on a preceding set of sheets is completed, the buffered sheet(s) together with the first consecutive sheet are fed further along supply path D to the intermediate sheet deposition station.

[0031] The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.